

refluxed at 60° C. in the following molar ratio: 1:3.8:1.5×10<sup>-5</sup>. The sol was cooled to room temperature. Additional water was added, and the HCl concentration was increased to approximately 0.01 M. Following stirring for 15 minutes at 25° C., the sols were diluted with 2 equivalents ethanol. In one preparation, an iron-exchanged dodecylsulfate surfactant, Fe(DS)<sub>2</sub>, was added. In a second preparation, a copper-exchanged dodecylsulfate surfactant, Cu(DS)<sub>2</sub>, was added. These two surfactants were prepared according to Moroi et al. (Moroi, T., Motomura, K., Matuura, J., Colloid Interface Sci. 1974, 46, 111, incorporated by reference herein). An aqueous solution of 0.2 M sodium dodecylsulfate (SDS) was mixed with 0.3 M of either ferrous or copper chloride. The solution was kept at 2° C., and a precipitate appeared. The precipitate was washed several times with a 0.1 M iron or copper chloride solution and recrystallized in distilled water and vacuum dried. The reactant mole ratios TEOS:EtOH:H<sub>2</sub>O:HCl:surfactant were 1:22.5:0.004:0.093-0.31.

Films were deposited on silicon wafers by dip-coating at a speed of 7.6-51 cm/min or by spin-coating at 2000-8000 rpm. Films were coated on silicon wafers and calcined in air at 400° C. for 3 hours or in hydrogen at 400° C. for 3 hours. The resulting materials have certain magnetic properties.

The invention being thus described, it will be apparent that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

We claim:

1. An evaporation-induced self-assembly method to prepare a liquid, crystalline film mesophase material, comprising:

mixing a precursor sol, a solvent, a surfactant, and an interstitial compound to prepare a silica sol, wherein said surfactant is at a concentration less than the critical micelle concentration; and

evaporating a portion of the solvent from said silica sol to form a liquid, crystalline, film mesophase material.

2. The method of claim 1 further comprising the step of heating said liquid, crystalline, film mesophase material to form a surfactant-templated film.

3. The method of claim 2 wherein the step of heating removes a portion of said surfactant.

4. The method of claim 3 wherein the surfactant-templated film has pores of diameter of approximately less than 200 Å.

5. The method of claim 3 wherein the surfactant-templated film has a surface area greater than approximately 100 cm<sup>2</sup>/cm<sup>2</sup> film surface.

6. The method of claim 1 wherein the interstitial compound is physically entrapped within said liquid, crystalline, thin film mesophase material.

7. The method of claim 1 wherein the precursor sol is selected from the group consisting of tetraethylorthosilicate, tetraethylorthosilicate, titanium butoxide, titanium isopropoxide, zirconium n-butoxide, aluminum iso-propoxide, and aluminum iso-propoxide.

8. The method of claim 1 wherein the interstitial compound is selected from the group consisting of organoalkoxysilanes, proteins, dyes, and metal-containing compounds.

9. The method of claim 8 wherein the interstitial compound is selected from the group consisting of tridecafluoro-1,1,2,2,-tetrahydrooctyltriethoxysilane, mercaptopropyltrimethoxysilane, rhodamine B, cytochrome c, and 3-(2,4-dinitrophenylamino)propyl(triethoxy)silane.

10. The method of claim 2 wherein the surfactant-templated film is an ordered material with at least two x-ray diffraction peaks in the range 2θ=0.5-10°.

11. The method of claim 2 wherein the surfactant-templated film is a disordered material with one x-ray diffraction peak in the range 2θ=0.5-7°.

12. The method of claim 2 wherein the surfactant-templated film is exposed to ammonia vapor to promote condensation.

13. The method of claim 1 wherein the surfactant is selected from the group consisting of sulfates, sulfonates, phosphates, carboxylic acids, alkylammonium salts, gemini surfactants, cetyl ethylpiperidinium salts, dialkyldimethylammonium, primary amines, poly(oxyethylene) oxides, octaethylene glycol monodecyl ether, octaethylene glycol monohexadecyl ether and block copolymers.

14. The method of claim 1 wherein the solvent is selected from the group consisting of an alcohol, formamide, and tetrahydrofuran.

15. The method of claim 1 wherein the step of evaporating a portion of the solvent is performed by a method selected from the group consisting of spin-coating, spray-coating, dip-coating, and aerosol processing.

16. The method of claim 15 wherein the silica sol is coated onto a substrate by a method selected from the group consisting of spin-coating, spray-coating, and dip-coating.

17. The method of claim 16 wherein said substrate is selected from the group consisting of a crystal silicon wafer and a piezoelectric crystalline quartz substrate.

18. The method of claim 1 wherein the interstitial compound is selected from the group consisting of a hydrophobic molecule, an oligomer, and a polymer.

19. An evaporation-induced self-assembly method to prepare a porous, surfactant-templated film, comprising:

mixing tetraethylorthosilicate, alcohol, water, an acid, a surfactant, and tridecafluoro-1,1,2,2,-tetrahydrooctyltriethoxysilane, wherein said surfactant is at a concentration less than the critical micelle concentration, to form a homogeneous mixture;

coating a substrate with said homogeneous mixture, said coating inducing evaporation of a portion of the solvent to produce a liquid, crystalline film mesophase material; and

heating said liquid, crystalline film mesophase material to decompose said surfactant, forming a porous, surfactant-templated film.

20. The method of claim 19 wherein the surfactant is cetyltrimethylammonium bromide.

21. The method of claim 20 wherein the molar ratios of tridecafluoro-1,1,2,2,-tetrahydrooctyltriethoxysilane:tetraethylorthosilicate:alcohol:water:cetyltrimethylammonium bromide are 0.15:0.85:21.8:5.1:0.0053.

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